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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/926,188	09/20/2001	Toshihiro Ando	011147	4371

23850 7590 10/07/2002

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EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 10/07/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

(15A) -8

Office Action Summary	Application No.	Applicant(s)	
	09/926,188	ANDO ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-7 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-7 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 20 September 2001 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. 0.
3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). ____ |
| 2) <input checked="" type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>5,6</u> | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 6 recites the limitation "hydrogen plasma exposure treatment" in line 2. There is insufficient antecedent basis for this limitation in the claim.
3. Claim 7 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 7 cites the limitation of "a substrate temperature lies in a range between 700 and 1100°C". The examiner suggests deleting "lies in a range", so the claim reads as "a substrate temperature between 700 and 1100°C".
4. A broad range or limitation together with a narrow range or limitation that falls within the broad range or limitation (in the same claim) is considered indefinite, since the resulting claim does not clearly set forth the metes and bounds of the patent protection desired. Note the explanation given by the Board of Patent Appeals and Interferences in *Ex parte Wu*, 10 USPQ2d 2031, 2033 (Bd. Pat. App. & Inter. 1989), as to where broad language is followed by "such as" and then narrow language. The Board stated that this can render a claim indefinite by raising a question or doubt as to whether the feature introduced by such language is (a) merely exemplary of the remainder of the claim, and therefore not required, or (b) a required feature of

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the claims. Note also, for example, the decisions of *Ex parte Steigewald*, 131 USPQ 74 (Bd. App. 1961); *Ex parte Hall*, 83 USPQ 38 (Bd. App. 1948); and *Ex parte Hasche*, 86 USPQ 481 (Bd. App. 1949). In the present instance, claim 7 recites the broad recitation a range of 700-1100°C, and the claim also recites preferably 830°C, which is the narrower statement of the range/limitation.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Imai et al (US 5,001,452) in view of Imai et al (JP 01-103994), an abstract of JP 01-103994 has been provided, along with Jin et al (US 5,977,697).

Imai et al ('452) discloses a method of forming a n-type diamond semiconductor (col 1-8) using a reaction gas composed of CH_4 , H_2S and H_2 to form S-doped diamond films on the (100) face of a single crystal diamond substrate by microwave plasma assisted CVD process (Example 1) with a electron mobility of $590 \text{ cm}^2/\text{V}\cdot\text{s}$ (Table 1).

Imai et al ('452) does not disclose mechanically polishing a diamond substrate to make it an inclined diamond substrate.

In a method of growing a diamond single crystal free from defects and having a smooth surface by specifying the orientation of the growth face of the substrate, Imai et al (JP '994)

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teaches a diamond single crystal layer is grown on a diamond single crystal substrate in a vapor phase, where a polished face having less than a 8° angle to the face orientation of (111) or (100) face is used as the growth face of the substrate and by this method a diamond single crystal layer having satisfactory crystallinity and a flat surface can easily be produced (Abstract).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Imai et al ('452) with Imai et al (JP '994) to grow of crystal of diamond free of defects and having a smooth surface.

The combination of Imai et al ('452) and Imai et al (JP '994) does not disclose subjecting a surface of the inclined diamond substrate to a smoothening treatment making it even.

In a method of forming diamond emitters, note entire reference, Jin et al teaches a diamond thin film is loaded into a microwave plasma chamber for surface treatment, this reads on applicant's smoothening treatment, where the plasma was pure hydrogen and the plasma chamber was operated at a microwave power of 1 kW (1000 W) and a total pressure of 20 Torr, a substrate temperature of 700°C and plasma exposure for 60 minutes. Jin et al also teaches after the treatment process the sample was subjected to a diamond overcoat process in the plasma chamber using methane gas at a substrate temperature of 700°C (col 9, ln 45-67). Jin et al also teaches the hydrogen plasma cleans the diamond surface by removing carbonaceous and oxygen or nitrogen related contaminants and also introduces hydrogen-terminated diamond surface and the plasma also removed any graphite or amorphous carbon phases present on the surface and along the grain boundaries (col 5, ln 15-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al ('571) and Imai et al (JP '994) with Jin et al to clean the surface and remove amorphous phases, thereby improving crystallinity.

Referring to claim 1-2, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of making a n-type semiconductor diamond as applicant. the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al is silent to the crystalline perfectness, the Raman peak, a Kikuchi pattern, carrier concentration and carrier mobility of the n-type diamond. It is inherent to the n-type diamond taught by the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al to have same because the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of forming a n-type diamond as applicant.

Referring to claim 3, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a polished inclined diamond substrate and smoothening the substrate prior to deposition of a n-type diamond by microwave plasma.

Referring to claim 4, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a (100) orientated substrate.

Referring to claim 5, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a polished diamond (100) face so that its face is inclined at an angle less than 8° , this reads on applicant's angle in a range between 1.5° and 6° , with respect to its $\langle 100 \rangle$ plane in a plane made by either its $\langle 100 \rangle$ and $\langle 010 \rangle$ direction or its $\langle 100 \rangle$ and $\langle 001 \rangle$ directions.

Referring to claim 6, the examiner interpretes the smoothening treatment to comprise a hydrogen plasma exposure. The combination of Imai et al ('571), Imai et al (JP '994) and Jin et

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al teaches a pressure of 20 Torr, a microwave output of 1000 W, a temperature of 700°C for a period of 1 hour.

Referring to claim 7, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a temperature of 700°C.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Nishibayashi et al (US 5,500,077) teaches a diamond substrate was set to 800°C and an amorphous state exposed to a hydrogen plasma was removed, thereby the surface of the diamond was flattened, this reads on applicant's smoothening (Example 7).

Tsuno et al (US 5,474,021) teaches the temperature and growth plane of a substrate are result effective variable for the growth of diamond single crystal by microwave plasma CVD (Example 1).

Akitomo (JP 02-263791) teaches a method of smoothening a diamond film using hydrogen plasma (abstract).

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the

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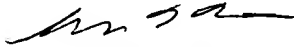
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organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
October 3, 2002


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